Excavation and volatile analysis in icy asteroid simulant: Preliminary results

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The wide interest in understanding small solar system objects such as asteroids and comets in the recent years is on display internationally in the form of multiple science missions (ROSETTA, DAWN, OSIRIS-ReX), planned crewed missions to a captured asteroid fragment (ARM) and the emergence of new industries seeking to uncover and exploit the resources of asteroids. Carbonaceous chondrites (C-type) are of particular interest because their formation and their composition are of great interest for both scientists studying the early solar system, and technologists interested in volatile resources such as water ice and carbon compounds for space resource utilization. It is essential to determine icy regolith excavation forces under vacuum conditions in an effort to down-select technology pathways for future planetary surface exploration missions, which may seek to capture small samples or perform large-scale excavation of materials.

We report here the preliminary results of a project performed at Kennedy Space Center Swamp Works aiming at fabricating icy regolith for C-type asteroids in a relevant vacuum environment and to characterize the mechanical properties of the regolith as a function of ice content using penetration, excavation, and sample capture devices. We examine the choices of mineral materials selected for the synthesis of a new simulant material and the associated technical challenges in their preparation and characterization prior to use. Further challenges include preparing icy regolith at cryogenic temperatures inside a (dirty) vacuum chamber, and controlling the environment during excavation (low temperatures, and high-vacuum pressure). We report on initial data on the behavior of the simulant under relevant conditions and penetration forces as well as on the correlation between characterization data of the water content of the minerals and the evolution of volatiles during excavation.

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